भारतीय मानक
Indian Standard

IS 17045 : 2018

रोटरी टिलर (रोटावेटर) — ट्रैक्टर संचालित — परीक्षण पद्धति, चुनिंदा कार्यकारिताएं एवं मापदण्ड के लिए अनुशंसाएं

Rotary Tiller (Rotavator) — Tractor Driven — Test Procedure, and Recommendations on Selected Performance Characteristics

ICS 65.060.99

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भारतीय मानक ब्यूरो
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Agricultural Machinery and Equipment Sectional Committee, FAD 11

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards after the draft finalized by the Agricultural Machinery and Equipment Sectional Committee had been approved by the Food and Agriculture Division Council.

A rotary tiller (rotavator) is any of several types of farm implement used for secondary tillage. The name refers to frames with the teeth (also called shanks) that pierce the soil as they are dragged through it linearly. In another sense it refers to the machines that use rotary motion of disks or teeth to accomplish a similar result.

Rotary tiller is used after the harvesting has been done using combine harvester, to remove the straw left. It cuts the straw and mixes it with the soil, thus, helps in avoiding the burning of the straw.

In the preparation of this standard, considerable assistance has been received from Central Farm Machinery Training and Testing Institute, Budni and Northern Region Farm Machinery Training and Testing Institute, Hisar.

The composition of the Committee, responsible for the formulation of this standard is given at Annex F.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*).’ The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ROTARY TILLER (ROTAVATOR) — TRACTOR DRIVEN — TEST PROCEDURE, AND RECOMMENDATIONS ON SELECTED PERFORMANCE CHARACTERISTICS

1 SCOPE

1.1 This standard prescribes the method of testing for tractor driven rotary tiller (rotavator) in respect of performance of operation and soundness of construction.

1.2 Assessment of the evaluative requirements applicable for qualifying minimum performance criteria of the rotary tiller (rotavator).

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No	*Title*
4468 (Part 1) : 1997	Agricultural wheeled tractors — Rear-mounted three-point linkage: Part 1 Categoies 1, 2 3 and 4
4468 (Part 2) : 1993	Agricultural wheeled tractors — Three-point linkage: Part 2 Category 1 N (narrow hitch)
4931 : 1995	Agricultural tractors — Rear mounted power take off types 1, 2 and 3
11082 : 1984	Technical requirements of agricultural tractors for wet land cultivation
6690 : 1981	Blades for rotavator for power tillers
7640 : 1975	Test code for disc harrows
9253 : 2013	Agricultural wheeled tractors — Field performance and haulage tests — Guidelines
10740 : 1983	Recommendation for operating requirement for power take-off driven implements
10318 : 2002/ ISO 5673 : 1993	Agricultural tractors and machinery — Power take-off drive shafts and position of power-input connection (*first revision*)
8132 : 1999/ ISO 3600 : 1996	Tractors and machinery for agriculture and forestry, powered lawn and garden equipment — Operator's manuals — Content and presentation (*second revision*)
11531 : 1985	Test code for puddler

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Rotary Tiller (Rotavator) — Rotavator is a tractor-drawn implement which is mainly used for seed bed preparation within one or two passes and is suitable in removing and mixing residual of maize, wheat, sugarcane etc., thereby, helps to improve soil health and save fuel, cost, time and energy as well.

3.1.1 There shall be following types of rotary tillers:

a) Based on mounting
   1) Centrally mounted, and
   2) Offset mounting.
b) Based on method of drive
   1) Gear drive, and
   2) Chain drive.
c) Based on rotor speed
   1) Single speed, and
   2) Multi speed.

3.2 Confidential Test — The test conducted for providing confidential information on the performance of rotary tiller (rotavator) whether ready for commercial production or not, or to provide any special data that may be required by the manufacturer/applicant.

3.3 Commercial Test — The tests conducted for establishing performance characteristics of rotary tiller (rotavator) that are ready for commercial production or already in production.

3.3.1 *Initial Commercial Test* — The tests conducted on indigenous or imported prototype of rotary tiller (rotavator) ready for commercial production.

3.3.2 *Batch Test (Conformity of Production)* — The tests conducted on rotary tiller (rotavator) which have already undergone initial commercial test and are being manufactured/sold commercially in the country. First batch test shall be carried out after 3 years from the date of release of initial commercial test report and subsequent batch tests after a period of every 5 years from the previous batch test. The validity period of initial commercial test report will be 3 years and 5 years for batch test.

3.3.3 *Repeat Test* — The tests conducted on rotary tiller, to ascertain the re-occurrence of breakdown/defects observed in earlier tests, for the same parameter and on the same sample under the test after rectifying the defects or after replacing the defective part/sub-assembly by new part/sub-assembly of the same specifications.

3.3.4 *Administrative Extension* —The changes which do not affect rotary tiller (rotavator) performance as given in Table 2 and which requires physical inspection only. The testing station which carried out the original test can issue an "administrative extension report'. The administrative extension report shall contain a reference to the original test report.

3.3.5 *Technical Extension* — If manufacturer desires, some features may be declared as optional features which are not affecting rotary tiller (rotavator) performance with base model, same shall be inspected/verified on the same sample under test and shall be incorporated in the Initial Commercial Test (ICT) report.

3.4 Non Evaluative Requirements — Requirements under this category are the ones which are not mandatory for acceptance of the Rotary tiller (rotavator) for the purpose of commercial production/subsidies. However, the authorized testing agency may observe the performance for these requirements and record in the test report.

3.5 Soil Pulverization — The process of breaking of soil into smaller aggregates through sieve analysis (IS 7640 : 1975).

3.6 Puddling — The mechanical manipulation of soil in presence of still water in the field to create a least pervious layer that prevents the loss of water through percolation and facilitate the transplanting of paddy seedlings by making the soil softer.

3.7 Field Capacity

3.7.1 *Theoretical Field Capacity* — It is the rate of field coverage that would be obtained if the machine were performing its function 100 percent of the time at the rated speed and always covering 100 percent of its rated width. It is given by the formula:

$$\text{Theoretical field capacity, ha/h} = \frac{S \times W}{10}$$

where,

S = speed of travel, kmph; and

W = rated width of implement, m.

3.7.2 *Effective Field Capacity* — It is the actual average rate of coverage by the machine. Effective field capacity (ha/h) is measured by area covered per unit time. The rotary tiller (rotavator) shall be operated for continuous field work for at least 1 h and the area covered during the period shall be measured in hectares.

3.7.3 *Field Efficiency* — It is the ratio of effective field capacity to the theoretical field capacity and is expressed in percent.

3.8 Puddling Index — It is the ratio between volume of settled soil and total volume of sample and it is given by the formula:

$$\text{Puddling Index (\%)} = \frac{V_s}{V} \times 100$$

where,

V_s = volume of settled soil, cc; and

V = total volume of sample, cc.

3.9 Bulk Density — It is the mass of the soil per unit volume. This is also known as the apparent density. If the density of soil is high, it is said to be more compact. Bulk density shall be calculated on dry basis.

The bulk density is given by the formula:

$$D = \frac{M}{V}$$

where,

D = bulk density, g/cc;

M = mass of soil, g; and

V = total volume of composite soil, cc.

3.10 Percolation — Is the downward movement of water through saturated or nearly saturated soil in response to the force of gravity.

3.11 Infiltration — The movement of water from the surface into the soil is called infiltration. Infiltration rate is the rate at which water can enter the soil under specific condition, including the presence of excess water.

3.12 Wheel Slippage

3.12.1 *Wheel Slip (For Dry Land Operation)* — This shall be determined by the following formula:

$$\text{Slip, percent} = \frac{100\,(N_1 - N_2)}{N_1}$$

where,

N_1 = Sum of revolution of driving wheels for a given distance when the tractor is driven under load, and

N_2 = Sum of revolutions of driving wheels for the same distance when tractor is driven without load.

3.12.2 *Travel Reduction (For Wet Land Operation)* — This shall be determined by the following formula:

$$TR = \frac{100\,(D_1 - D_2)}{D_1}$$

where,

D_1 = Distance travelled in metres on load for 5 or 10 revolutions of wheel, m and

D_2 = Distance travelled in metres at no load in 5 or 10 revolutions of wheel, m.

3.13 Wheel Sinkage — Sum of reading of water over puddle and the reading of depth of puddle. It is expressed in, cm.

4 GENERAL GUIDELINES

4.1 Selection

For commercial test, the rotary tiller (rotavator) shall be selected at random from the production line or as directed by the testing authority. The rotary tiller (rotavator) shall be complete with all its usual accessories and in condition generally offered for sale. The rotary tiller (rotavator) shall be new and should not be given any special treatment or preparation for test. The manufacturer may submit prototype for confidential test report. The nature of test shall be stated by the manufacturer.

4.2 Specification Sheet

The manufacturer/applicant shall supply the specification of the rotary tiller (rotavator)consisting of the items listed in the specimen report given in Annex A, as well as any other information required by the testing authority to carry out the tests. The manufacturer/ applicant should also supply technical literature such as operational, maintenance and service manuals, and parts catalogue.

4.3 Running-in

The manufacturer/applicant shall run-in the machine before test under his responsibility and in accordance with his usual instructions. The running-in shall be carried out in collaboration with the testing authority or the procedure agreed to with the manufacturer/applicant. After running-in, servicing and preliminary settings should be done according to the printed literature supplied by the manufacturer/ applicant. The place and duration of running-in shall be reported.

4.4 Servicing and Preliminary Setting after Running

After completion of running-in, servicing and preliminary settings should be done according to the printed literature supplied by the manufacturer/ applicant.

4.5 Repairs and Adjustments during Tests

All the repairs and adjustments made during the tests shall be reported.

5 MEASURING TOLERANCES

The measuring apparatus shall be such that the following items shall have the tolerances within the limits shown against each:

a)	Rotational speeds, rev/min	±0.5 percent
b)	Time	±0.2 s
c)	Distance, m or mm	±0.5 percent
d)	Force, N and torque, N-m	±1.0 percent
e)	Mass, kg	±0.5 percent
f)	Atmospheric pressure, kPa	±0.2 percent
g)	Tyre pressure, kPa	±5 percent
h)	Temperature of fuels etc, °C	±2 percent
j)	Wet and dry bulb temperatures, °C	±0.5 percent
k)	Fuel consumption,	±1 percent

6 TESTS

Various tests to be conducted on rotavator are given in Table 1.

7 LABORATORY TESTS

7.1 Checking of Specification

The specifications supplied by the manufacturer as given in Annex A shall be checked and reported.

7.2 Hardness of Soil Engaging Parts (Rotary Tiller Blades)

The hardness of blades are determined at edge and shank portions as per IS 6690, and shall be reported as in Annex B.

Table 1 Tests to be conducted on Rotary Tiller (Rotavator)

Sl No. (1)	Tests (2)	Ref. to (3)	Remarks (4)
i)	Checking of specification	Refer Annexure A	
ii)	Laboratory test 1. Hardness of soil engaging parts (Rotary tiller blades) 2. Chemical analysis of critical components (Rotary tiller blades) 3. Wear analysis of critical components (Rotary tiller blades)	*See* **7**	
iii)	Field test (dry land and wet land) a) Rate of work b) Quality of work c) Effectiveness of sealings for Wet land operation; d) Ease of operation, maintenance and adjustments; e) Labour requirement; and f) Defects, breakdowns and repairs.	*See* **9**	
iv)	Special characteristics	—	If any

7.3 Chemical Analysis of Critical Components (Rotary Tiller Blades)

The material of rotor blades are analyzed as per IS 6690, and shall be reported as in Annex B.

7.4 Wear Analysis of Critical Components (Rotavator Blades)

The wear of blades on dimensional and mass basis are calculated and expressed in percentage per hour.

8 SELECTION OF LAND AND PREPARATION OF SAMPLE FOR FIELD TESTS

8.1 Selection of Land

8.1.1 The minimum area of the plot for testing tractor operated rotary tiller (rotavator) shall be 0.4 ha. The ratio of width and length of the plot should be, as far as possible, 1 : 2, and the plot selected should have not been given any previous tillage treatment after the last crop harvested.

8.1.2 The following field conditions of the plot shall be checked and reported:

a) Size of the plot;
b) Type of soil;
c) Last crop grown;
d) Details of the preceding tillage treatments, if any, after the harvesting of last crop;
e) Topography of the field;
f) Soil moisture percentage, as per IS 9253, and soil condition shall be as per IS 11531;
g) Bulk density of the soil;
h) Cone index of the soil. and
j) Soil pulverization by sieve analysis.

8.2 Preparation of the Sample

8.2.1 The testing authority shall ensure that the rotary tiller (rotavator) has been properly assembled and lubricated after laboratory test.

8.2.2 All the attachments and accessories required for field use shall be fitted in place and the adjustments made shall be in accordance with the manufacturer's recommendations (*see* **4.1**).

8.2.3 The rotary tiller (rotavator) shall be properly hitched with the source of power, as far as possible, the same horse power range of tractor should be used for testing as specified by the manufacturer.

9 FIELD TESTS

The field tests of the rotary tiller (rotavator) comprising of dry and wet land operations shall be conducted for 25 and 10 h respectively. The details of tractor used shall be reported in test report. If rotary tiller (rotavator) is recommended only for dry land operation the information should be embossed on sample.

9.1 Rate of Work

9.1.1 *Speed of Operation*

The speed of operation of the rotary tiller (rotavator) shall be recorded in dry and wet land condition.

9.1.2 *Quality of Work*

9.1.2.1 *Quality of work in dry land*

Measure the width and depth of cut for maximum 10 places and obtain the average of the reading.

9.1.2.1.1 *Field efficiency*

9.1.2.1.1.1 *Theoretical field capacity*

On the basis of the theoretical width of rotavator and speed, calculate the theoretical field capacity by the following formula in **3.7.1**.

9.1.2.1.1.2 *Field efficiency*

$$\text{Field efficiency, percent} = \frac{\text{Effective field capacity}}{\text{Theoretical field capacity}} \times 100$$

9.1.2.2 *Quality of work in wet land*

9.1.2.2.1 *Depth of puddle*

A special probe of 25.4 mm diameter and 1000 mm long, graduated in millimeters shall be used to measure the depth of puddling by penetrating it vertically into the puddle. The depth at which the force required to push the rod manually into the puddle, increases by 2 kg shall be taken as the depth of puddle. And Record the depth of puddle at different 10 places of plot after puddling has finished and report the average of ten readings in cm.

9.1.2.2.2 *Puddling index*

For determining the puddling index the samples of soil-water suspension shall be taken by immersing a glass tube to a depth of about 100 millimetres. The samples shall be taken from a number of points and shall be collected in measuring cylinders. These shall be kept undisturbed for 48 hours to allow the soil to settle. The volume of settled soil shall be noted for computing the puddling index. And it is the ratio between volume of settled soil and total volume of sample and it is given by the formula in **3.8**.

9.1.3 *Average Fuel Consumption*

The rotary tiller (rotavator) shall be operated continuously for at least three hours and fuel consumed during this period should be recorded and reported in liter per hour.

9.1.4 *Wheel Slippage*

Rear wheel revolution of tractor should be taken for a distance of at least 20 metre on load and no load condition for at least consecutive three runs and percentage wheel slippage should be calculated as per **3.12.1**.

9.1.5 *Travel Reduction (For Wet Land Operation)*

The travel reduction for wet land operation should be calculated as per **3.12.2**.

10 EFFECTIVENESS OF SEALINGS FOR WET LAND OPERATION (*see* IS 11082)

After completion of field test in wet land operation for 10 h, the implement is dismantled for checking effectiveness of sealing's provided against ingress of dust and water/mud in various sub-assemblies and also to check the condition of components of the rotavator.

Sl No.	*Location*	*Whether Ingress of Mud and/ or Water was Observed*
(1)	(2)	(3)
1	Primary reduction gear box	Yes / No
2	Secondary reduction gear box	Yes / No
3	Rotary axle bearing cap	Yes / No

11 EASE OF OPERATION, MAINTENANCE AND ADJUSTMENTA

Any inconvenience occurred/maintenance and adjustments carried out during the field/ lab tests should be reported in test report.

12 DEFECTS, BREAKDOWNS AND REPAIRS

Any defects, breakdowns and repairs occurred during the field/ lab tests should be reported in test report.

13 SUMMARY OF OBSERVATIONS, COMMENTS AND RECOMMENDATIONS

For reducing the data to a usable form, prepare a summary report of observations, comments and recommendations.

14 ACCEPTANCE CRITERIA FOR PERFORMANCE CHARACTERISTICS

The product may be accepted for performance after confirming compliance to all evaluative requirements. Performance characteristics of rotary tiller (rotavator) along with the tolerances with respect to the declared values and in certain cases minimum/maximum values are given in Table 2.

15 ACCEPTANCE CRITERIA IN CASE OF BREAKDOWNS/DEFECTS

15.1 The product may be accepted subject to the following conditions:

a) There is no 'critical breakdown' during its validation after all tests including repeat tests;

b) There are not more than one 'major breakdown'; and

c) There are not more than three 'minor breakdowns/ defects' during the test and the frequency of each is not more than two.

NOTES

1 In no case, the total number of breakdowns should exceed four, that is (1 major + 3 minor) or 4 minor defects.

2 In case of single critical breakdown/more than one major breakdown/ more than four minor defects and their frequency being not more than two, the 'Repeat Test' as defined in **3.3.3** above may be conducted.

15.2 In case of multiple consequential failures resulting from a single defect/breakdown, the primary single defect/breakdown shall only be counted.

15.3 Categorizations of defects in terms of 'Critical', 'Major' and 'Minor' for various sub-assemblies/parts are provided in the **Annex C, D** and **E**.

Table 2 Parameters Applicable for Qualifying Minimum Performance Criteria

(*Clause* 14)

Sl No.	Characteristics	Category Evaluative/Non Evaluative	Requirements a	Tolerances	As Observed	Whether Meets the Requirement (Yes/No.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	**Field Performance**					
i)	Suitability for Wet land operation	Evaluative	Should be suitable for Wet Land operation	—	—	Yes/No
ii)	Depth of cut in dry land operation, (cm)	Evaluative	Minimum 10 cm.	—	—	Yes/No
iii)	Depth of puddle in wet land operation, (cm)	Evaluative	Minimum 12 cm.	—	—	Yes/No
iv)	Field efficiency, (percent)	Evaluative	Minimum 75 percent	—	—	Yes/No
v)	Puddling index, (percent)	Evaluative	Minimum 65 percent	—	—	Yes/No
2.	**Safety Requirements**					
i)	Safety considerations	Evaluative	Should meet the requirement of IS 10740 and IS 10318	—	—	Yes/No
ii)	Safety clutch/ device (Shear bolt) in PTO drive shaft	Evaluative	Should be provided	—	—	Yes/No
iii)	Rotavator stand	Evaluative	Should be provided	—	—	Yes/No
iv)	Rotavator shield to prevent flying of mud & stone	Evaluative	Should be provided	—	—	Yes/No
v)	Guard over propeller shaft	Evaluative	Should be provided	—	—	Yes/No
3.	**Effectiveness of Sealings** (presence of ingress of dust and water/mud in various sub assembles)					
i)	Primary reduction gear/box	Evaluative	No ingress of mud and water	—	—	Yes/No
ii)	Secondary reduction gear/box	Evaluative	No ingress of mud and water	—	—	Yes/No
iii)	Rotary axle bearing cap	Evaluative	No ingress of mud and water	—	—	Yes/No
4.	**Material of Construction**					
i)	Hardness of blade	Evaluative	High carbon steel, boron steel	—	—	Yes/No
ii)	Chemical composition of rotor blade	Evaluative	As per IS 6690	—	—	Yes/No
5.	**Dimensional Requirements**					
i)	Dimensions of three point linkage	Non-Evaluative	Should meet IS 4468 (Part 1)	—	—	Yes/No
ii)	Dimensions of power input connection (PIC) of Implement	Non-Evaluative	Should meet IS 4931	—	—	Yes/No
iii)	Dimensions of power input connection (PIC) Yoke bore	Non-Evaluative	Should meet IS 4931	—	—	Yes/No
6.	**Literature (Submission to Test Agency)**					
i)	Operator cum service manual and parts catalogue	Evaluative	Should be provided as per IS 8132	—	—	Yes/No

Table 2 (*Concluded*)

Sl No.	Characteristics	Category Evaluative/Non Evaluative	Requirements a	Tolerances	As Observed	Whether Meets the Requirement (Yes/No.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
7.	**Labeling of Rotavator (Provision of Labeling Plate) as Per Above and Should be Welded on Rotary Tiller (Rotavator)**					
	Parameters	Evaluative	Should be provided on Rotary Tiller (Rotavator)	—	—	Yes/No
	Name and address of manufacturer					
	Make					
	Model					
	Size (m) [Dia of rotor × width of cut]					
	Country of origin					
	Year of manufacturer [DD/MM/YYYY]					
	Chassis Serial Number					
	Recommended PTO speed of prime-mover, (rpm)					
	Maximum PTO Power required, kW					
8.	**CATEGORY OF BREAKDOWNS/DEFECTS (*see* 15.1)**					
	Category of Breakdown	**Category (Evaluative/Non Evaluative)**	**Requirements**		**As Observed**	**Whether Meets the Requirement (Yes/No.)**
i)	Critical breakdown	Evaluative	No critical breakdown			Yes/No
ii)	Major breakdowns	Evaluative	Not more than one and neither of them should be repetitive in nature			Yes/No
iii)	Minor breakdowns	Evaluative	Not more than three and frequency of each should not be more than two.			Yes/No
iv)	Total breakdowns	Evaluative	In no case, the total number of breakdowns should exceed four, that is, (1 major + 3 minor) or 4 minor breakdowns			Yes/No

ANNEX A

(*Clauses* 4.2)

SPECIFICATION SHEET

(To be filled by Manufacturer / Testing Engineer)

A-1 GENERAL

Name of Manufacturer and Address :

Name of Applicant and Address :

Name of machine :

Type :

Make :

Model :

Year of manufacture :

Serial number :

Recommended Power source :

Type of blade :

Size (cm) [Rotor Dia. x working width] :

A-2 PRIME MOVER USED

Tractor :

Chassis No./ Engine no. :

Max. PTO Power, kW (Ps) :

A-3 CONSTRUCTIONAL DETAILS :

1. Main frame
2. Side plate
3. Rotor shaft
4. Rotor blade
5. Primary reduction gear box
6. Secondary reduction gear box
7. Skid
8. Hitch pyramid

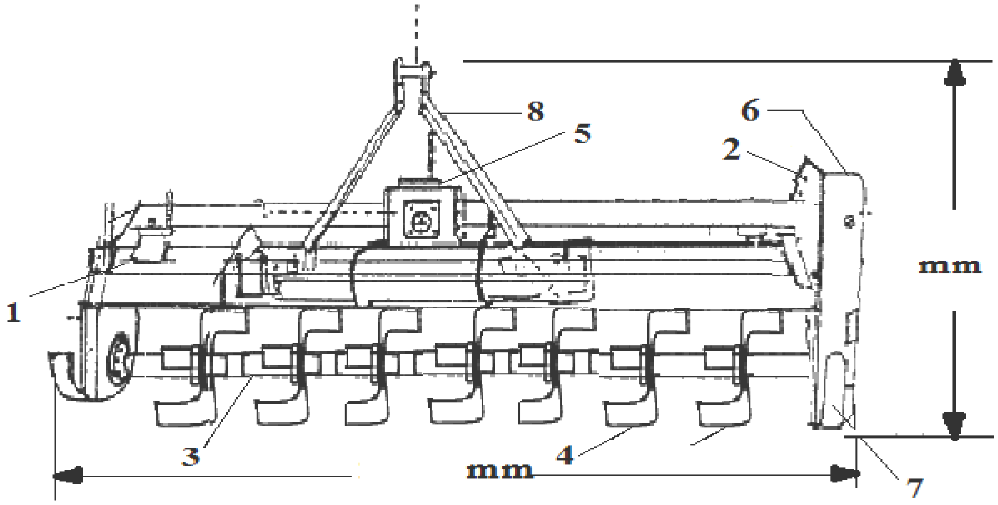


Fig. 1 Rotar Tiller

A-3.1 Main Frame

Type :
Size of box section, (mm) :
Size of supporting flat, (mm) :
Type of mounting of box section :

A-3.2 Side Plates

Type :
Thickness of plate, (mm) :
Size of bolt
Length, (mm) :
Dia.,(mm) :
Method of fixing :

A-3.3 Shield (Cover)

Type :
Size, (mm) :
Method of mounting :

A-3.4 Trailing Board

Type :
Material :
Size of board, (mm) :
Thickness of sheet, (mm) :
Locking system :
Method of mounting :
Size of rod, (mm) :
No. of bush :
Size of bush, (mm) :
Type of hinge :
No. of hinges :
Method of fixing :

A-3.5 Rotor

A-3.5.1 *Axle*

Material :
Type of rotor axle :
Size of shaft, (mm) :
No. of flanges :
Type of flanges :
Dia. of flange, (mm) :
Thickness of flange, (mm) :
No. of blades on each flange :
Method of mounting blades on flange :
Distance between two flanges, (mm) :
Total no. of blades :
Dia. of rotor with blades, (mm) :
Method of fixing :

A-3.5.2 *Rotor Blades*

Number :

Type :

Material (apa) :

Overall thickness, (mm) :

Thickness at beveled edge, (mm) :

Length of the beveled edge, (mm) :

Speed of rotor shaft corresponding to 540 rpm of PTO shaft, (rpm) :

Peripheral speed of rotor blades, (m/min.) :

A-3.6 Depth Control Mechanism

A-3.6.1 *Skid*

Type and Material :

Size, (mm):

Curved length :

Width :

Thickness :

No. of skids :

Method of fixing :

A-3.6.2 *Adjusting Rack*

Type :

Dia of hole for depth adjustment, (mm) :

Range of depth adjustment, (mm) :

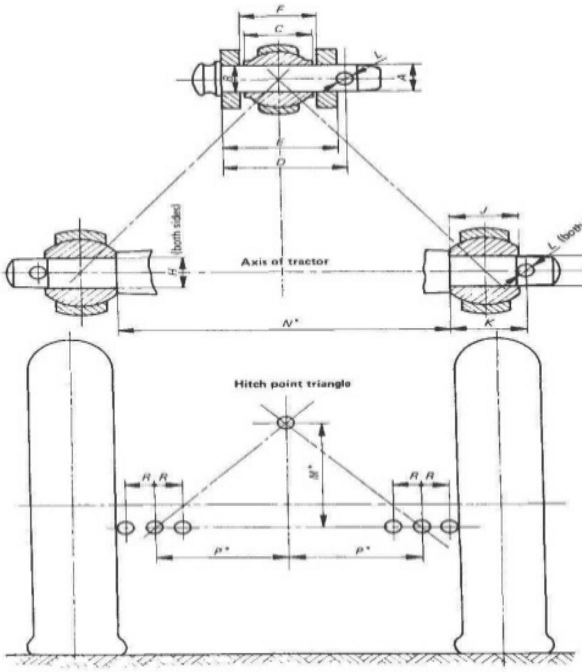
Method of mounting :

A-3.7 Hitch Pyramid

Constructional details :

Notations	Specifications	Dimensions, in mm As per IS 4468	As Measured (mm)	Remarks
Upper Hitch Point				
A	Dia. of hitch pin			
B	Dia. of hitch pin hole			
F	Width between inner faces of yoke			
E	Width between outer faces of yoke			
D	Linch pin hole distance			
L	Dia. of linch pin hole			
Lower Hitch Points				
H	Dia. of hitch pin hole			
—	Width between inner faces of yoke			
—	Width between outer faces of yoke			
G	Dia. of hitch pin			
K	Linch pin hole distance			

L	Dia. of linch pin hole
M	Mast height
N	Lower hitch point span



A-3.7.1 *Mast*

Type :

Size of flat, (mm) :

Shape :

A-3.8 **Power Transmission System**

Method of operation :

A-3.8.1 *Primary Reduction*

Type :

No. of teeth on drive gear :

No. of teeth on driven gear :

Reduction ratio at gear box :

No. of teeth on pinion :

No. of teeth on crown gear :

Reduction ratio at gear box :

Oil capacity, (l) :

Grade of oil :

Oil change period, (h) :

Length of power transmission shaft, (mm) (from gear box to secondary reduction unit) :

Dia of shaft, (mm) :

Provision of breather :

Provision for checking oil level :

No. of bearing :

No. of bearing :

A-3.8.2 *Dimensions of Power Input Connection (PIC) of Implement*

Specification	As per IS 4931 : 1995	As Observed	Remarks
Nominal speed (rpm)			
No. of splines			
Direction of rotation			
Dimensions (mm)			
DΦ			
dΦ			
BΦ			
A Φ			
W			
a			
b			
c			
x			
B			
Horizontal distance between PIC and Lower Hitch point	150* (IS 10318)		
Vertical distance between PIC and Lower Hitch Point	100 ± 100* (IS 10318)		

*Recommended dimensions. It may be necessary to vary them in the case of specialized implements.

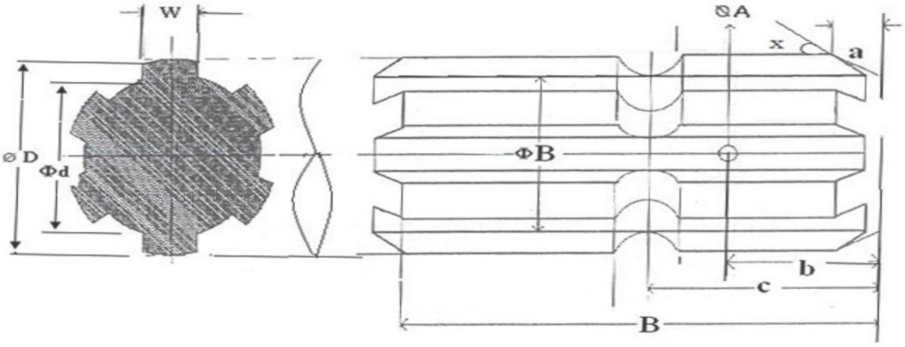


Fig. 3 Dimensions of Power Input Connection (PIC) of Implement

A-3.8.3 *Secondary Reduction*

Type :

No. of gears :

Type of gear :

No. of teeth on drive gear :

No. of teeth on driven gear :

No. of teeth on idle gear :

Reduction ratio :

Oil capacity, (l) :

Grade of oil :

Oil change period, (h) :

Oil level checking bolt :

No. of bearing :

A-3.8.4 *Power Take Off Drive Shaft*

Type :

Length of the shaft (mm):

Closed :

Extended :

Mass of shaft (kg) :

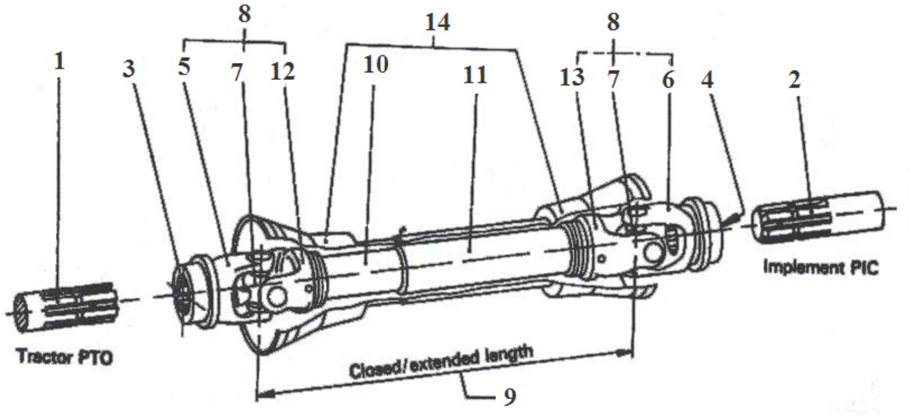


FIG. 4 PTO DRIVE SHAFT

KEY

1	PTO	8	Universal Joint
2	PIC	9	PTO Drive Shaft, Closed and Extended Length
3	PTO Yoke Bore	10	Inner Shaft
4	PIC Yoke Bore	11	Outer Shaft
5	PTO Yoke	12	Inner Shaft Yoke
6	PIC Yoke	13	Outer Shaft Yoke
7	Journal Cross- Assembly	14	PTO Drive Shaft Guard

Dimensions of PIC yoke bore: —

Sl No. (1)	Notations (2)	Dimensions (mm) As per IS 4931 (3)	As Observed (4)	Conformity to IS (5)
1	DΦ			
2	dΦ			
3	W			
4	B			

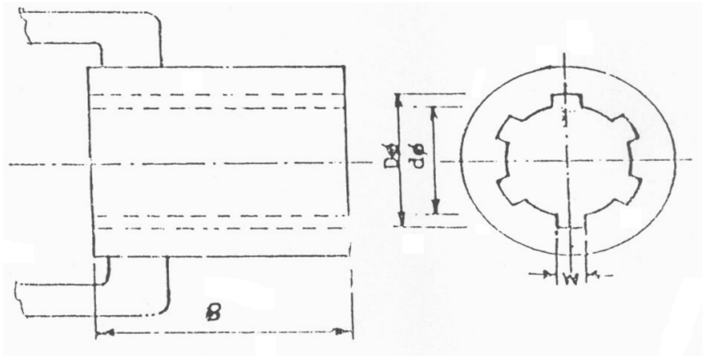


FIG. 5 PROPELLER SHSFT INSERT DIMENSIONS, (MM)

A-3.9 **Safety Clutch/Device** :

A-3.10 **Rotavator Stand** :

A-3.11 **Overall Dimensions (Ref. Fig. 1):**

Length, (mm) :

Width, (mm) :

Height, (mm) :

A-3.12 **Operational Mass, (kg)** :

A-3.13 **Colour** :

A-3.14 **Marking/Labeling of Implement**

Labeling plate shall be riveted on the implement with the following information:

	Parameter	Details
1	Name and Address of Manufacturer	
2	Make	
3	Model	
4	Size (m) [Dia of rotor x width of cut]	
5	Country of origin	
6	Year of manufacturer [DD/MM/YYYY]	
7	Chassis Serial Number	
8	Recommended PTO speed of prime-mover, (rpm)	
9	Maximum PTO Power required, kW	

ANNEX B

B-1 HARDNESS OF ROTOR BLADE

Sl No.	Hardness				Remarks	
	As per IS 6690		As observed (HRC)			
	Shank portion	Edge portion	Shank Portion	Edge portion	Shank portion	Edge portion
1	(37 - 45 HRC) 344 - 411	(56 ±3 HRC) 512 - 634				

B-2 CHEMICAL COMPOSITION OF ROTOR BLADE

Constituents	As per IS 6690		Composition As observed (Percent of weight)	Remarks
	Carbon Steel	Silicon Manganese Steel		
Carbon (C)	0.70 - 0.85	0.50 - 0.60		
Silicon (Si)	0.10 - 0.40	1.50 - 2.00		
Manganese (Mn)	0.50 - 1.0	0.50 - 1.00		
Sulphur (S)	0.05 (max)	0.05 (max)		
Phosphorous (P)	0.05 (max)	0.05 (max)		

ANNEX C

(*Clause* 15.3)

CATEGORIES OF BREAKDOWNS/DEFECTS ROTARY TILLER (ROTAVATOR)
(Critical Breakdown)

Code	Aggregate	Critical Defect	Sub Assembly	Applicable Norms
1	2	3	4	5
C-1	Rotary Tiller	Breakage/Crack of	Power input shaft	As under col 3 and 4
C-2	--do--	--do--	Transmission Gears	--do--
C-3	--do--	--do--	Propeller shaft	--do--
C-4	--do--	--do--	Primary gearbox	--do--
C-5	--do--	--do--	Secondary gearbox	--do--
C-6	--do--	--do--	Rotar shaft	--do--

ANNEX D

(*Clause* 15.3)

CATEGORIES OF BREAKDOWNS/DEFECTS ROTARY TILLER (ROTAVATOR) (Major Breakdown)

Code 1	**Aggregate** 2	**Major Defect** 3	**Sub Assembly** 4	**Applicable Norms** 5
Mj-1	Transmission	Breakage/Crack of	Drive chain	As under col 3 and 4
Mj-2	--do--	Failure of	Bearing	--do--
Mj-3	--do--	Breakage/Crack of	Sprocket	--do--
Mj-4		Breakage/Crack of	Rotor blades (Originating from mounting holes)	--do--

ANNEX E

(*Clause* 15.3)

CATEGORIES OF BREAKDOWNS/DEFECTS ROTARY TILLER (ROTAVATOR) (Minor Breakdown)

Code 1	**Aggregate** 2	**Minor Defect** 3	**Sub Assembly** 4	**Applicable Norms** 5
Mn-1	Sealings	Oil Leakage from	O ring	As under col 3 and 4
Mn-2	--do--	--do--	Gasket	--do--
Mn-3	--do--	--do--	Primary reduction unit (gearbox)	--do--
Mn-4	--do--	--do--	Secondary reduction unit (Gearbox)	--do--

FIELD OBSERVATION DATASHEET FOR ROTARYTILLER (DRY LAND OPERATION)

Test No.		**Test Starting Time**		**Place of Test**	
Date		Test finishing time		Type of soil	
Name of Supervisor and Staff		Name of implement		Soil Moisture (percent)	
		Make and model of tractor		No load wheel revolutions (in 25 cm)	RHS: LHS:
Name of operator		Gear used for operation		Furrow length (m)	

Sl No.	**Time taken in 25 m**	**On load wheel rev. in 25 m**		**Depth of out (cm)**	**Width of 5passes (m)**	**Soil pulverization (cm)**	**Taming time (sec)**	1. Engine speed (rpm i) No load ii) On load
								2. Total duration of test (h)
		RHS	**LHS**					3. Total stoppage (h)
1								4. Net run hours (h)
2								5. Total fuel consumption (l)
3								6. Av. Forward speed (kmph)
4								7. Area covered (ha/h)
5								8. Time required (h/ha)
Total								9. Field efficiency (percent)
Avg.								10. Soil Pulverizaiton (cm)
13	Fuel comsumption							11. Power requirement kW (Ps)
14	Avg. wheel stoppage (percent)				15. soil bulk density (g/cc)			12. Fuel consumption
Stoppage	Reasons					Stoppage		Reasons

(a) Condition of test plot 1) Last crop grown 2) Date of last crop harvested: 3) Details of previous tillage treatment 4) Topography of field:	(b) Condition of tractor: 1) Steering easiness 2) Whether engine stalls/momentary overload iii) Can implement be adjusted from operator’s seat iv) Suitability of hydraulic system v) Defects and breakdown if any

1) Cone index readings (mm):— Depth (cm)	0	05	10	15	20	21	22	23	24	25	26	27	28	29	30
Before operation															
After operation															

2) Ease of operation and Adjustments:- i) Whether the implement is balanced during operation? ii) Is there any marked clogging of soil in the flange/axle/side flange/rotor drive? iii) Any leakage/stepage of oil from gearbox/reduction unit of Rotavator iv) Any mark of compaction of soil after operation v) quality of operation vi) Is there any deformation and breakage of parts noticed during the test?	

FIELD OBSERVATION DATASHEET FOR ROTARY TILLER (WET LAND OPERATION)

Test No.		Name of machine		Place of test	
Date		Gear selected for		Type of soil	
Starting time		Forward speed		No load PTO speed (rpm)	
Finishing time		Rotor speed			
Superisor and Staff		operator		On load PTO speed (rpm)	

Sl No.	**Time Taken to Cover 10 Drive Wheel rev. (sec)**	**Distance Covered in 10 Drive Wheel rev. (m)**				**Depth of Standing Water (cm)**	**Wheel Sinkage (cm)**	**Puddle Depth (cm)**	**Water Over Puddle (cm)**	**Cone Depth (cm)**
		On load		**No load**						
		RHS	**LHS**	**RHS**	**LHS**					
1										
2										
3										
4										
5										
Total										
Avg.										

1	Total duration of test (h)		6	Avg. forward speed (Kmph)	
2	Total stoppage (h)		7	Travel reduction (percent)	
3	Net run (h)		8	Pudding index (percent)	
4	Total fuel consumption (l)		9	Area puddle (ha/h)	
5	Fuel consumption (l/h)		10	Time required (h/ha)	

Sl No.	**Condition of Test Plot:**		**Sl No.**	**Condition of Tractor**	
1	Last crop grown		1	Steering easiness	
2	Surface growth type, height and intensity		2	Pattern and type of cage wheel	
3	Details of previous tillage treatment		3	Whether engine stalls/momentary overload	
4	Topography of field		4	Can implement be adjusted from operator's seat	
			5	Suitability of hydraulic system	
			6	Defects and breakdowns if any	

Sl No.	**Initial Value**	**Volume of Puddled Soil (After 48 h Settling Period) (cc)**		**Puddling Indes (Percent)**
1		Mud	Water	
2				
3				
Average				

(D) Ease of operation and Adjustments:- 1) whether the implement is balanced during operation? 2) Is there any marked clogging of soil in the flange/axle/side flange/rotor drive? 3) Any leakage/seepage of oil from gearbox reduction unit of Rotavator. 4) Any mark of compaction of soil after operation 5) Quality of puddling 6) Is there any deformation and breakage of parts noticed during the test?	

ANNEX F

(*Foreword*)

COMMITTEE COMPOSITION

Agricultural Machinery and Equipment Sectional Committee, FAD 11

Organization	*Representative(s)*
Central Institute of Agricultural Engineering, Bhopal	Dr K. K. Singh (***Chairman***)
Agriculture Machinery Manufacturer's Association (AMMA), Pune	Shri Balachandra Babu Dr Surendra Singh (*Alternate*)
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CAPTAIN Tractors Pvt Ltd., Rajkot	Shri Shailash Movaliya
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National Innovation Foundation	Shri Mahesh Patel Shri Rakesh Maheshwari (*Alternate*)
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Northern Region Farm Machinery Training and Testing Institute, Hisar	Shri P. K. Pandey
Power Tillers Manufacturers Association	Shri B. Sathyamurthy
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Punjab Agricultural University, Ludhiana	Dr GursahibSingh
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Tractor Manufacturers Association	Shri R. P. Vasudevan Shri T. R. Keshwan (*Alternate*)
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Member Secretary
Shri Pawan Kumar
Scientist 'B', BIS

Panel on Rotary Tiller, FAD 11/P-1

Organization	*Representative(s)*
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